THESIS FOR DEGREE OF DOCTOR OF PUBLIC HEALTH

"A STUDY IN THE CONTROL OF TYPHOID FEVER IN RURAL AREAS"

BY

Kenneth F. Maxcy

1921.

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The decline in prevalence of typhoid fever in the rural areas of the United States is doubtless due to a multiplicity of causes whose relative values vary with the locality concerned. For convenience, these causes may be placed in two general groups,- one to include the general or natural forces operative throughout the country to a greater or less degree, and the other to include artificial causes operative locally and due to the efforts of public health authority. Some evidence of the existence of the former has been offered in the preceding study. The present study is concerned with the application of the latter to rural conditions.

With notable exceptions, current sanitary practice in the prevention of typhoid is a resultant of successive steps in knowledge of the way in which the disease is spread,- irrespective of the conditions under which the original observations were made. Thus the formula may be briefly stated as:

(1) Protection of water supplies
(2) Proper disposal of sewage.
(3) Protection of milk supplies.
(4) Anti-fly measures.
(5) Bed-side prophylaxis.
(6) Antityphoid vaccination.

There seems to be a general tendency to base action against typhoid along these lines in much the same way whether the area involved is a densely populated urban district or a thinly populated rural area.

It is assumed that the nature and conditions of transmission of the disease are the same in both instances: to wit, that it is an epidemic disease due principally to polluted drinking water or milk; that when these two cannot be blamed flies are responsible; that a few cases are due to direct contact with persons sick with the disease. It is heald furthermore that the same necessity exists in the country as in the city of attributing a given case to "polluted well-water", "dirty milk" or "fly-born infection".

With this point of view the reduction of typhoid in rural areas has seemed to depend upon sanitary conditions i.e. the proper location and protection of wells, cleanliness in handling milk, sanitary privies, reduction of flies and similar measures. As a second line of defense recourse has been taken in many instances to wholesale vaccination of the community. Campaigns of this kind may be described as extensive in character. They have doubtless had their effect in reducing morbidity from typhoid in the rural districts.

In this paper it is desired to call attention to certain differences that exist between the conditions of transmission in the organized, densely populated urban community on the one hand, and the relatively unorganized, thinly populated farming district on the other. Evidence is presented to show that in the latter instance a more intensive method of control is practicable and may be more economic and effective. The data is derived from an analysis of the situation in Kansas,- a fairly representative state with a large rural population.

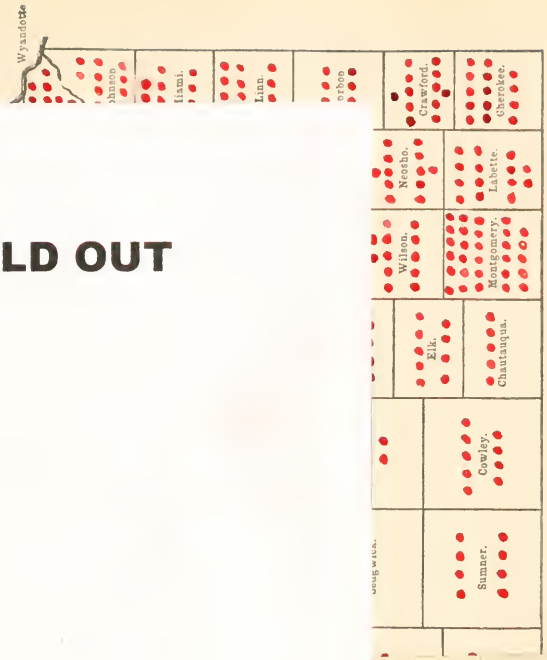
If the geographic distribution of cases in Kansas in any one year or succession of years is studied, one is impressed with the fact that the disease is more endemic in its character than epidemic. The annual toll is made up by a case here and one there, four or five cases in this county perhaps twenty or thirty in another, often occurring in groups of twos or threes in different neighborhoods at different times during the year. Occasionally a definite small epidemic of some fifteen or twenty cases occurs. The disease flourishes in summer and autumn, becomes quiescent in winter and spring, only to burst forth the following year,- reaching maximum at about the same time each year, varying slightly in the total number of cases and the localities of maximum incidence. If the deaths for a six year period (Graph #) are plotted on the basis of population by counties, it is found that certain areas are prone to have a constantly high rate as compared with others,- a tendency toward focal distribution which is born out upon examination of the situation in individual counties. Year after year cases occur in certain communities in a county while others in the same county are relatively immune.

The seasonal distribution of deaths from typhoid fever in the rural areas of Kansas are shown in Graph # 3 . It will be noted that 87% of the deaths occur in the last six months of the year. The maximum is reached in September; minumum in Februaxy. During the five years on which this graph was based there were no epidemics of "winter typhoid". The curve is similar to that found in cities where the water supply is perfect or nearly so, and so far as it goes would imply that water must play an exceedingly small role in the dissemination of the disease in rural Kansas.

The following instances of the occurrence of typhoid in rural sections of the state are typical:

FOLD OUT

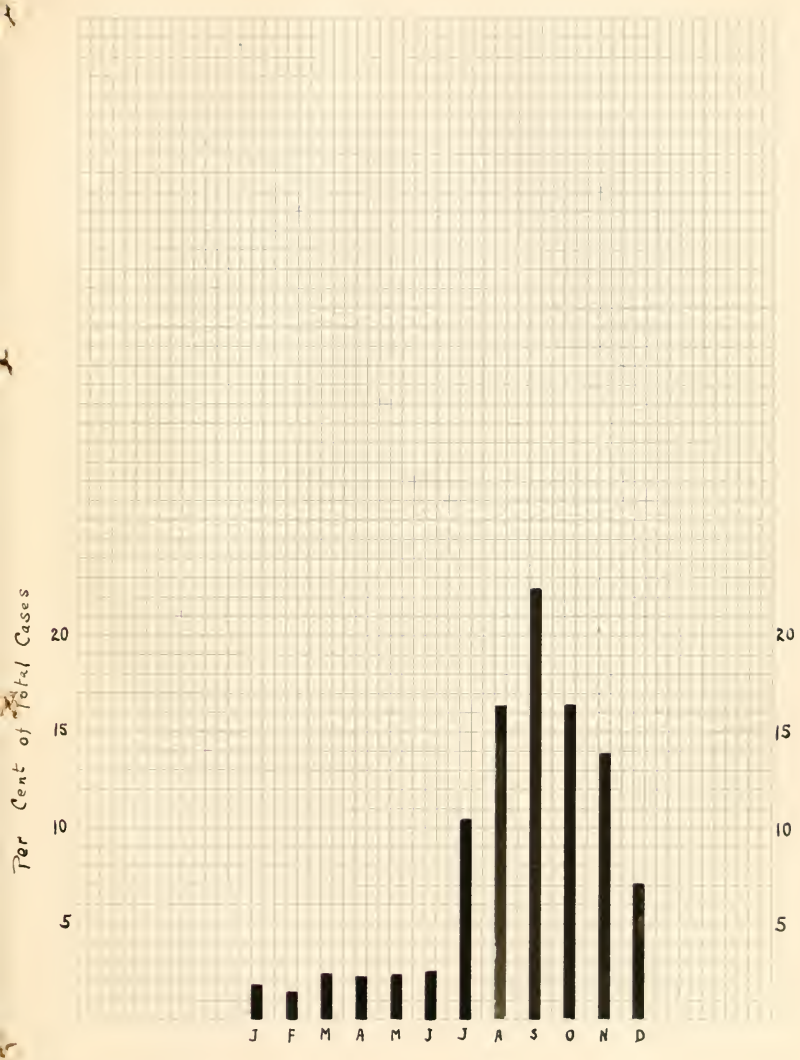
ph III-Seasonal Distribution of Typhoid Fever Cases in Rural Kansas, based on the 5-year period 1914-18.



FOLD OUT

period 1914 - 1918 (inc.)
by counties

h III-Seasonal Distribution of Typhoid Fever Cases
in Rural Kansas, based on the 5-year period 1914-18.



ph III—Seasonal Distribution of Typhoid Fever Cases in Rural Kansas, based on the 5-year period 1914-18.

Small Epidemic of Typhoid Fever

Originating at a Church Social.

(This epidemic occurred in a thinly populated farming district centering about the village of O. The village itself had possibly one hundred inhabitants. It consisted of two general stores, a lunch room, a hotel ?, a bank, church and school about which were grouped a cluster of houses. The church was without competition within several miles so that it attracted practically all of the religiously inclined in this neighborhood. Most of the typhoid which had occurred in this county in the past 25 years had been reported from this general section. There had been no serious outbreaks in the past five years, but two or three cases occurred in and about the village of O. each year.) Previous to the outbreak to be described there had been no known cases in this part of the county for a year or more.)

On July 30th, L.H. a girl working in the lunch room in the village of O. became ill and her physician strongly suspecting typhoid fever advised her immediate removal to her home in a nearby town. In the next few days this case was quickly followed by others, here and there, on this farm and that, in the country surrounding. When an investigation was made, nineteen persons were found ill with the clinical symptoms of typhoid. Sixteen of the nineteen fixed their onset between July 30th and Aug.10th

Laboratory examinations were made to confirm the clinical diagnosis in several of the cases. Serum from three showed a very definite agglutinating power 1/[illegible]0 against a common laboratory strain of B. typhosus. Four [illegible] ten stool cultures which were examined the same [illegible]. The strain recovered appeared typical in every respect [illegible] cultural and serological reactions.*

(Foot Note)

* The technique for the detection of the typhoid bacillus in stools was that generally adopted. A small bit of fecal material - preferably from a fluid stool after the use of a cathartic - was collected in a 1 oz. bottle containing about 15 cc of a solution consisting of Normal salt sol. 80 pts. and glycerine 20 pts. This was transported to the laboratory and without unnecessary delay plated out on Endo's. At the end of 24-48 hrs., suspicious colonies were pickedd off and inoculated upon Russel's media (triple sugar with Andrade indicator). If the reaction was typical of B.typhosus, the slant was examined for purity, morphology, staining reactions, and motility. If a pure culture of a gram negative motile bacillus was found , the growth was taken up in suspension in salt solution. This was then tested for its agglutinability with a known antityphoid serum. The antityphoid serum upon which chief reliance was placed was a horse serum with a very high titre(1/40,000)obtained from Dr. Bull. All of the strains obtained from carriers were subsequently sent to Dr. N.P.Sherwood, Professor of Bacteriology, at the University of Kansas, for confirmation.

The explosive character of the outbreak suggested a common vehicle of infection. Assuming the average incubation period of the disease to be about fourteen days and having determined the modal date of onset for the first sixteen cases to be August 5th, the date of the infection was placed tentatively at somewhere about July 20th. The fact that the three remaining cases developed after August 15th was held to be not inconsistent with this hypothesis inasmuch as incubation periods as long as five or six weeks are known to be not uncommon.

The Vehicle of Transmission.

There being no common water or milk supply, it seemed that the vehicle of transmission must be some article of food or drink consumed by these nineteen persons on some special occasion about the date mentioned. There had been three community gatherings in the month of July,- a picinc on July 5th, and ice cream socials at the church on July 16th and 30th. Suspicion naturally attached to the gathering on the 16th, and questioning brought out the fact that all of the persons ill had attended this function and all had eaten ice cream. Since this was the only article of food served and many of those ill denied drinking any water while at the social, it seemed clear that it must be the vehicle of transmission.

The possibility that the common dises and spoons used in serving the ice cream [illegible] through which the infection was distributed was considered. This seemed particularly important when it was found that they had merely been rinsed in cold water before being used again. If the person to whom the duty of washing dises had been assigned had

been a carrier conceivably the dish water might have become the vehicle of transmission. Upon inquiry it was found that Mrs. F. had had entire charge of the dish washing. Her history was carefully inquired into but was entirely negative in regard to typhoid. This possibility was therefore dismissed as unlikely, the contamination assumed to be in the ice cream itself, and a search for the source of the contamination undertaken.

The Source.

In investigating the source of contamination we, attention was first directed to the conditions under which the ice cream had been made. The ladies to whom the task had been assigned had gathered at the parsonage on the afternoon preceding the social. With them they had brought the milk cream and eggs donated by various farms in the surrounding territory. Mrs. C.P. had portioned out the milk; B.P. and E.L. had added the necessary quantities of sugar, eggs and flavoring extract. Contrary to the usual custom the mix was not cooked because it was a very hot day and the wife of the preacher, in whose home they were at work, lay ill in bed and would have been made uncomfortable by the heat of the stove. The mix was divided into several freezers operated by members of the congregation [illegible] and willing helpers who had gathered around.

Several leads for further investigation were suggested by this story:- the ice, the ladies who mixed the ice cream, the illness of the minister's wife, and the milk used.

Ice can be dismissed with a word. It was crystalline natural ice which had been stored six months and was therefore sterile. The farm from which it had been obtained was investigated and there was no history of typhoid associated with it. The investigation of the ladies who had mixed the ice cream was unfruitful in a similar manner. On the other hand, the illness of the minister's wife appeared at first to be a significant fact. Upon careful inquiry, however, it was found that her illness had been exceedingly mild and had consisted of vague abdominal discomfort urticarial eruption and practically no fever at any time. The possibility of an atypical mild attack was ruled out by a completely negative widal reaction and stool culture.

The investigation now resolved itself into a search for the source of contamination of the milk. That the infection had come through this vehicle was made eminently possible by the fact the ice cream mix had not been cooked and by the fact that it has been demonstrated that freezing milk with a dasher ice cream freezer does not kill typhoid organisms.

The milk and cream had been donated by ten different farms. Each had furnished approximately three quarts of milk and one quart of cream It had all been mixed together in one large kettle so that if any one lot had been contaminated it would have been distributed throughout the mix. Inasmuch as it was an exceedingly hot day the rapid multiplication of bacteria was favored.

Each of the ten farms was visited. All the persons living or working on the farm were listed. Inquiry was made as to whether they had previously had typhoid and when; whether there were any sick at present with typhoid; concerning anti-typhoid vaccination, who did the milking and how it was handled, general sanitary arrangements, etc.

On five of the ten farms there were cases of typhoid resulting from the ice cream social. In the absence of other significant history, it was considered relatively unlikely that the carrier was located on one of these farms, else these persons ~~xxuldxxlxexdx~~, having been non-immunes, would probably have been infected previously. Farm #6 was excluded since although two of the old folks had had the fever in 1880, there had been no cases since in a large household. On farm #10 there was an absolutely negative history of typhoid and moreover the milk from this particular farm had been heated before it was sent to the church. This narrowed the search to three farms adjoining each other and whose occupants were interrelated.

On farm #3 the farmer himself, Mr. U.T. had had typhoid in 1886. Two of his children, G.U. and E.U., had had it in 1912. Neither his wife nor the other six children had ever had it. Stool cultures from E.U. and G.U. were negative.

On farm #2 there lived a young couple, H.D. and his wife and two small children. The wife was G.U. referred to in the preceding paragraph as having had typhoid in 1912. H.D. himself a son of the family to be referred to below had had 'walking typhoid' in 1906. His stool culture was also negative.

There remained only Farm [illegible]. This farm had been passed over at first as not suspicious because no case of typhoid had ever occurred on it, so far as was known. The reason later became obvious. In it there were living at this time Mr. A.H.D. his wife and one son. They gave an interesting history. In the year 1898, when this family had been living in a small town in Missouri, Mrs. A.H D. had become ill with a severe case of typhoid, lasting three months or more. Following her illness, Mr. A.H.D. had had the disease and after him five of their children. The following year three more of their children and several of their neighbors' children had had typhoid following a party given at their house. Only one of their own children of a family of ten had escaped. They moved to their present location near the village of O. in Kansas in 1905.

In the face of such a suggestive history, suspicion was naturally focused on the three living on this farm. The specimens of stool obtained from the two men were negative; that from Mrs. A.H.D., the mother of the family, was positive for B.typhosus. Evidently she was the carrier,- the source of contamination of the milk. Although the son had done the milking, she had been responsible for preparing the milk in a proper container for transportation to the church on the day of the social. This milk, probably contaminated by her hands, mixed with that from the other farms without being cooked, churned until frozen in the ice cream freezer, had then been responsible for the epidemic which struck down almost ten per cent of the population of that community of O.

This woman who was some 65 years of age had had the disease 22 years previously. She had been responsible for infecting her husband and nine of her children. She was very active socially

and interested in numerous community enterprises. She was in the habit of selling her dairy products, particularly butter, to persons living in and about the town of O. Her activities had given her abundant opportunities to disseminate the disease and she was doubtless responsible for many of the "sporadic" cases which had occurred in this area. What she had cost this area it is impossible to estimate. Dr. J.F.Hawley, who attended fourteen of the nineteen cases occurring in this epidemic estimated that the medical and nursing care alone for these persons amounted to some $2,700. Add to this the money spent for "extra help", time lost by wage earners, etc., and the financial expediency of adequate health protection is grasped. The cost of health protection is approximately $2 per capita per year. The cost of this epidemic alone was probably $20 per capita.

Comment: The local (part time) health officer had first attacked this epidemic by having the well water from the parsonage and several of the other farms examined. Most of these showed a somewhat excessive count and a few colon bacilli when examined at the State Water and Sewage laboratory after being 48 hours in transit. These wells were called unsafe. The investigation would doubtless have ended here had not the State supplied the necessary personnel to continue it.
If the "sporadic" cases which had been occurring in this town had been systematically investigated, this "carrier" would doubtless have been detected previously and this disastrous epidemic prevented.

Name	Age	Onset	Date to bed	Incubation Period*	Stool Culture	Widal
L.H.	21	July 30	August 1	14 days	-	----
M.P.	6	August 1	" 2	16 "	B.typhosus	----
F.G.	7	" 1	" 3	16 "	B.typhosus	----
V.O.	14	" 1	" 3	16 "	Negative	----
R.F.	24	" 1	" 5	16 "	B.typhosus	----
L.	39	" 1	" 6	16 "	Negative	Positive
K.B.	7	" 1	" 8	16 "	Negative	----
C.P.	4	" 3	" 4	17 "	---	----
S.P.	30	" 3	" 5	17 "	B,typhosus	Positive
O.B.	17	" 3	" 5	18 "	Negative	Positive
E.C.	47	" 3	" 5	18 "	Negative	------
L.O.	6	" 3	" 5	18 "	Negative	------
G.P.	24	" 5	" 10	20 "	----	------
C.B.	45	" 5	" 18	20 "	----	------
C.P.	3	" 6	" 9	21 "	----	------
M.B.	4	" 8	" 10	23 "	----	-------
L.B.	20	" 15	" 30	30 "	Negative	-------
V.P.	16	" 15	" 28	30 "	B.typhosus	-----
I.B.	40	" 21	" 28	37 "	-----	-----

*Incubation period calculated as time elapsing between ice cream social on July 16th and first day of definite illness.

TABLE - SUMMARY OF CASES OCCURRING IN THE "C" OUTBREAK, showing age distribution, date of onset, incubation period and laboratory findings.

Small Town Outbreak Propagated by a

Clerk in a Grocery Store.

The town of C.S. has a population of some 1500 individuals. There is a municipal water supply of excellent quality derived from deep wells. A large proportion of the inhabitants depend upon private wells. There is no common system of sewage disposal. Some feww houses are provided with septic tanks, but a majority have the ordinary type of pit privy. In general the town is clean and the premises well kept. In.1896 there had been a severe outbreak of typhoid, but since that time only sporadic cases, one or two per year, had occurred. The last previous case had been reported during the fall of the previous year from a farm about two miles outside the town.)

During August and September there occurred eight cases of typhoid in the town of C.S. The first case, a little girl aged six, had become ill about August 4th and had run a typical course of the disease. The source of her infection could not be ascertained. The next two cases (#2 and #3) contracted their infection from the first by direct contact. There was a definite history that these two little boys had visited and played with the little girl on August 14th while she was sick in bed. They came down with the disease sixteen to eighteen days later.

Case #4 was the father of the little girl (#1). He had been away on a vacation from August 16th to August 25th.

He felt perfectly well the day he returned but a few days later, September 5th, he began to feel badly, and went to bed on September 6th. He had a very mild attack. His fever was never higher than 100.5. He had definite "rose spots" on his abdomen at the onset. Although his case was diagnosed typhoid by his physician, he and his wife refused to believe it to be such. After about two weeks in bed, he was able to get up and a few days later resumed his work as clerk in a grocery store in the town.

So far the source of the infection was fairly obvious, with the exception of the first case. But now there were four cases in a row in widely separated parts of the town with no apparent relationship to each other or to the preceding cases. A mother and her daughter-in-law came down on September 13th and 14th, respectively, evidently infected at the same time. In another part of the town a little girl aged nine years came down with the disease on September 13th, and finally, Case 8, a little girl aged eleven, went to bed with typhoid on September 23d.

These cases could not be accounted for on the basis of contact. There was no common water or milk supply; no common eating place. One was forced to the conclusion that the infection had been distributed, by indirect contact, by flies, or by raw fruits or vegetables. Proceeding on the last hypothesis it was found that all four bought their fruits and raw vegetables at the same store-"P's". There were two other stores in town from which they might have purchased them. Investigating "P's" led to the discovery that this was the store in which Case 4, above referred to, was ill work. This seemed to establish

the link between the first and second group of cases.

It will be noted that Cases 4,5,6,7 and 8 might well have been infected at the same time, - bearing in mind the fact that the incubation period of typhoid varies from a few days to six weeks. Thus, if the father of the first case, returning home on August 29th, contaminated his hands on the following day, his own incubation period was seven days (large dose), and by the same dose Case #5 came down on the 12th day, #6 on the 16th day, #7 on the 15th day, and #8 on the 25th day.

When interviewed on September 30th, this man although he had been working in the store over a week, was obviously still convalescent. Stool cultures, made on two occasions thereafter showed large numbers of typhoid bacilli.

Comment: Proper isolation of the first case would have prevented this sequence of seven more.
A local physician deputized as Health Officer without the services of a visiting nurse or of expert consultation was ineffective in accomplishing this.
The role of contact and the carelessness with regard to a food handler are particularly noteworthy.

TABLE – Summary of Epidemiological Data in Small Town (C.S.) Outbreak.

Case No.	Age	Date of Onset First symptoms	To Bed	Water Supply	Milk Supply	Raw fruits & Vegetables	Contact
1	6	---	Aug. 4	Private well	Shoman	Pickerell	---
2.	5	Sept. 1	Sept.6	"	Plange	"	1 Aug.14
3.	7	Sept. 3	Sept.6	"	"	"	1 Aug.14
4.	37	Sept. 5	Sept.9	"	Shoman	"	1 Aug.29
5.	37	Sept. 5	Sept.10	"	Sedgewick	"	4 Aug.29?
6.	32	Sept. 7	Sept.14	"	"	"	4 Aug.29?
7.	9	Sept. 7	Sept.13	City	Chapman	"	4 Aug.29?
8.	11	Sept.20	Sept.23	City	Small	"	4 Aug.29?

A "TYPHOID FARM".

The threshing crew of John Worth threshed at the Smith farm from July 28th to July 30th. Two weeks later Worth's youngest daughter, Ruth, aged 12, and his son Roy, aged 21 become ill. They were quickly followed by Clarence Worth and three other members of the threshing crew. The clinical symptoms of all were typical of typhoid.

The incubation period suggested that all had been infected at the same time and that the source of the infection was the Snith farm. This hypothesis was strengthened by two other facts. First, the daughter Ruth had helped at the Smith farm but had not assisted at the farms on which the threshing crew had previously and subsequently worked. Secondly, an outbreak of typhoid had been traced to this same farm four years previously.

The Smith farm was visited and a history of the family obtained. It is summarized in Table [illegible]. It will be noted that the mother of the family had had "intermittent fever" in 1896. About the same time her son Roy, had "typhoid fever". No more cases could be traced until 1910. In that year, Roy married and settled on a farm near the old homestead. He and his wife frequently had their meals with the old folks. Six months after their marriage, Roy's wife had typhoid. There were no other cases in the neighborhood at the time.

Name	Relationship	Age	Typhoid History	Remarks
Francis	Father	-	----	Died of Bright's Disease in 1916. Aged 58
Clara	Mother	56	"Intermittent Fever" in 1896	Living on Smith farm.
Carl	Son	-	----	Died of "Brain abscess" in 1918, aged 33
Charles	Son	33	----	Married and moved away
Roy	Son	34	Typhoid in 1896 Wife had typhoid, 1910 Children, typhoid, 1916	Married and moved nearby
Earl	Son	-	----	Died of "cholera infantum" in 1890, aged 20 mos.
Merle	Son	28	Wife died of typhoid in 1916	Living on Smith farm.
Freddie	Son	-	----	Died of "whooping cough" in 1894. Aged 20 mos.
Rose	Daughter	34	----	Married and moved nearby.
Maud	Daughter	32	----	Married and moved away.
Lethe	Daughter	18	Had typhoid in 1916	Married and moved nearby.
Jesse	Daughter	16	----	Living on Smith farm.
Fleet	Son	14	----	Living on Smith farm.
Ina	Daughter	10	----	Living on Smith farm.

Table II- Pellagra Outbreak - Summary of History of Smith Family.

A lapse of six years occurred without any known cases. In 1916 Mr. Smith, the father of the family, became ill with his last illness and the family gathered at his bedside. John Dooley, a man who had been brought in to run the farm during the emergency, became ill with typhoid about one month after his advent. Soon after, Roy Smith's two children, Lillian and Eunice, aged six and four, who were spending most of their days at the old homestead, became ill with the disease. They were followed by Letha Smith who washed their bed clothing. Mrs. Merve Smith, a daughter-in-law, next became ill with the disease and died after a brief illness. Mrs. Troutmann, a neighbor who came in to help take care of the children was the next victim, and she subsequently gave rise to two contact cases, one of which gave rise to two more. This ended the chain in 1916,- a toll of ten cases due to original infection and contact.

An investigation of the Smith farm was made by the health authority at this time. A sample of water from the well was examined bacteriologically and pronounced unsafe. This was therefore considered to be the source of the infection. A new well was dug and the top properly protected with a concrete coping and the matter dropped.

Four years later, in 1920, in spite of this sanitary improvement, the six cases of typhoid in the Worth threshing crew were infected on the same farm. A human source was now sought.

Having obtained the complete family history as outlined above, suspicion naturally fell upon the mother of the family who had had "intermittent fever" in 1906. A specimen of stool was obtained and proved positive for Bacillus typhosus.

Mrs. Smith had cooked and served the meals for the threshing crew. A summary of the cases of typhoid for which she was responsible is appended in Table

Comment: Most of the cases occurring in the 1916 outbreak could have been prevented by an appreciation of the contagiousness of the disease, by proper nursing care, and by protecting the persons in contact through removal to another home or by vaccination.
"Passing the buck" to the well water is typical. Had the "carrier" been detected in 1916, the 1920 outbreak might have been prevented..

Mrs. Clara Smith } 1896
Roy Smith

5. Mrs. Roy Smith } 1909

4. John Dooley
5. Eunice Smith (Reported Aug. 6)
6. Lillian Smith
7. Letha Smith
8. Mrs. Marve Smith (Reported Aug. 17)
9. Mrs. Sara Troutman (Reported Aug. 14)
10. Leota Troutman (Reported Nov. 11)
11. Mrs. Ed. Troutman (nee Cardner)(Reported Dec. 10)
12. Ruth Gardner
13. John Gardner
} 1916

14. Ruth Worth
15. Ray Worth
16. Clarence Worth
17. Charles Harper
18. Alfred Bradford
19. Earnest Jarea
} Members of threshing crew.
Onset of all about Aug. 15, 1916.

Table III - Wellington Outbreak - Summary of Recognized Cases of Typhoid Fever Associated with the Smith Family.

SPORADIC OUTBREAK ON FARM.

During the first part of August 1922 an outbreak of four cases of typhoid fever was reported centering about the Brown farm four miles south west of the small town of W.C. There had been no previous cases in the county for over a year. Examination of the well water was requested but instead, an epidemiological investigation was made. Inquiry elicited the following data:

The Brown family consisted of Mr. Brown, his wife, a daughter Hazel, aged six, and a baby, Harriet, aged one and one half months. The two helpers on the farm, Beulah Roberts, and Tommy Sheffstall, had been employed on the place over a year.

Case #1 - Hazel Brown, aged 6, became ill on July 29th and went to bed on August 1st. At the time of the investigation she was in the third week of the disease and presented a typical clinical picture of typhoid.

Case #2- Howard Sanford, aged nineteen, living on the next farm in a farmhouse a half mile northeast of the Brown residence, began to feel badly about August 1st and went to bed on August 7th.

Case #3 - Amy Sheffstall, aged twenty-six, living in the town of W.C., had been employed at the Brown farm between July 7th and 17th, to attend Mrs. Brown at the time of her confinement. About August 9th she began to have fever and on August 14th went to bed with a typical case of typhoid.

Case #4 - Mr. Brown had become ill on August 14th and had immediately gone to a hospital in a nearby town for treatment. He was said to have typhoid.

A consideration of the dates of onset and attendant circumstances pointed fairly definitely to a source on the Brown farm during between July 7th and 17th. Questioning failed to suggest sources outside the Brown household. No suspicion attached to the two helpers on the farm both of whom were young and gave no history of a previous attack of typhoid. This left only Mrs. Brown to be considered. She gave a very definite history of typhoid two years previous. She had had a very severe attack and had never felt well since, complaining of vague abdominal symptoms. A stool culture from Mrs. Brown was positive for B. typhosus.

Evidently then Mrs. Brown was the "carrier" responsible for the outbreak. Her husband and daughter Hazel had been vaccinated against typhoid at the time of her illness two years previous. This had protected them up to the time that she gave birth to her child in July. With the soiling incident upon the delivery, they were probably subjected to overwhelming dosage and succumbed. This partial immunity may account for Mr. Brown's long incubation period, or he may have been a secondary contact with Hazel. The nurse, who was obviously exposed to the greatest degree, began to feel badly before she left the Brown farm on July 17th although she did not "give up" and go to bed until August 14th.

Case #2 on the adjoining farm could not be accounted for on the basis of direct contact. He is possibly an instance of fly-born infection. Sanitary conditions did not preclude.

Comment: A sporadic outbreak was definitely traced to a carrier.
Anti-typhoid vaccination failed to protect other members of the family after two years.
Fly-born infection might be the explanation of one of the cases.

THE MENACE OF THE UNSANITARY PRIVY IN A SMALL TOWN.

In 1920 a two-year-old child died of typhoid in the village of St. George. One year previously this child's sister, aged ten, had been sick eight weeks with the disease and recovered. A year previous to that, in 1918, a Mr. Light, aged 38, living across from this "H" family, had had a typical case, recovered and moved to another town shortly thereafter. There had been no other known cases in this vicinity during these three years. Each was apparently a sporadic case.

The "H" family had moved to this neighborhood four years previously. Neither the father nor the mother nor any of the other six children in the family had been sick with an illness that might have been typhoid so far as could be ascertained. No history of recent typhoid could be obtained in relatives, visitors, or neighbors, with the exception noted above - Mr. Light.

Both Mr. Light and the "H" family had used the same well - marked "W" on the diagram. This was thought by them to be the source of the infection. It was a dug well with tile casing and poorly protected top. From its location there was certainly a possibility of pollution. It was situated on the down slope from the "H" barn and the privy marked "p" on the diagram - not 200 feet away. It was in closer proximity to the other "privy "P". A bacteriological examination of the water from this well showed evidence of pollution - gas formation in three 1 cc tubes from which colon bacillus was recovered.

The investigation might have stopped at this point but it was still not clear how typhoid bacilli reached the well originally. Inquiry elicited the fact that the family using the privy "p" had moved to this neighborhood only eight months previously. They could not

TREASURY DEPARTMENT

UNITED STATES PUBLIC HEALTH SERVICE

COOPERATING WITH THE

KANSAS STATE BOARD OF HEALTH

PUBLIC HEALTH LABORATORY

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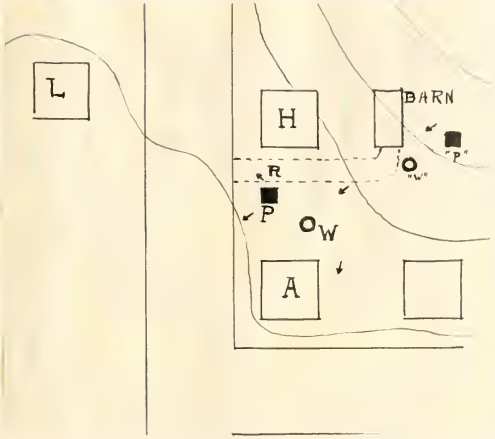

possibly have been responsible for the first two cases — 1911-12. On the other hand, the family using the privy "P" were all residents in the neighborhood, and it was found that the Mr. Light above referred to was their son-in-law. Although he had moved to another town, he and his wife often spent their week-ends with the old folks. This immediately suggested the thought that Mr. Light was still carrying his typhoid organisms with him. A specimen of stool was obtained from him and B. typhosus was found present in large numbers.

The explanation that now seemed most plausible was the following: At the time Mr. Light was taken ill with typhoid he was a clerk in one of the stores in town. Here he had a wide and varied contact and may have picked up his infection. On his return visits to the old home he used the privy "P". From this the infection reached the "H" children by direct hand contamination, through the polluted well-water, or possibly by flies.

Comment: The "lead" to the source of two sporadic cases in a small town was an unsanitary privy. Investigation showed that this privy was used by a chronic carrier on "week-end" visits. Its situation in close proximity to other dwelling houses made it a menace; on an isolated farm it would have had little power to do harm.

The preceding observations upon the character of typhoid fever in the rural areas of Kansas are of course very limited in scope. They are in harmony, however, with what has been found by others who have studied the problem in rural areas*.

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* 1. Klinger - "Epidemiologische Beobacttungen bei der Typhustekämpfung im Sudwesten des Reichs"
Arbeiten a.d.Kaiserliche Gesundheitsamte 1909 -30,504-609.

2. Ledingham - J.C.G. "The Enteric Fever Carrier"
Report of the Medical Officer, Local Government Board 1909-10 , appendix B, pp.246-385.

3. Chesley, Burns, Greene and Wade - "Three Years' Experience in the Search for Typhoid Carriers in Minnesota".
Jour. A.M.A. 1917 , 68 , pp. 1382-85.

4. Meader, F.M. - Unpublished

5. Norment R.B. - Unpublished

Rural typhoid appears to be more endemic than epidemic in character and tends to show a focal distribution. The vehicles of wholesale distribution - water and milk - are, to a large extent non-operative.. Efforts to block these modes of transmission are correspondingly unimportant. It is largely a question of what has been termed "residual","prosodemic" or "contact" typhoid in cities where water and milk have been made reasonably safe.

Defining rural typhoid then, as primarily "contact" typhoidtyphoid and using the term in its broad sense, it is evident that the contact is of two sorts. Contacts of non-immunes with clinical cases,- recognized or unrecognized - accounts for a great many infections. Indeed quite a considerable epidemic may be propagated by this means alone as has been demonstrated on an number of occasions. More important still are contacts with chronic carriers of typhoid bacilli. The latter hold

explanation for the "sporadic" cases in the country, for "typhoid furnes", etc., about which there has been so much mystification in the past.

It will be noticed that in each of the outbreaks above detailed a chronic carrier was either responsible for an explosive outbreak involving many persons or inaugurated a chain of cases which were kept going by contact of the sick with the well. Carriers as a source of infection hold a strategic position. They constitute the permanent reservoir of infection in a given community. They are a sort of catalase - without which the typhoid "reaction" of the community cannot proceed indefinitely. The magnitude and speed of the "reaction" depends upon the size of this reservoir, its relation to the water and food supply of the community, and the degree of community and personal cleanliness existent. The carrier starts the chain; unsanitary surroundings and contact continue it.

As Sir William Budd pointed out as far back as 1873, " for the development of this fever a more specific element is needed than either the swine the dungheaps or the privies were in the common course of things able to furnish. In the course of time, this element was added, and it was then found that conditions which had been without power to generate fever, had but too great power in promoting its spread once the germ of the fever had been introduced". Without negelcting the "swine, the dung-heaps, or the privies", and one might well add flies and well-water which have been made the scape-goat of many typhoid investigations, it is maintained that in the small towns and more or less thinly populated farming districts, it is practicable in a majority of instances to establish the "source" of this "specific element" - whether it be a clinical case or a chronic carrier. Effective and economic prevention demands that dissemination be blocked here if possible.

In the city, owing to the complexity of economic life and the multiplicity of daily human contacts, it has usually been impossible to trace infection to its human source. It has consequently been necessary to prevent dissemination by blocking the usual routes of transmission, so far as was practically feasible. Attention has been focused upon water-supply, milk-supply, raw-foods, and flies and upon reported cases rather than upon tracing down unreported cases and carriers. In the rural districts, on the other hand, the situation is simplified.

The extracorporeal life of the typhoid bacillus is comparatively short*. The vast majority of organisms die

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* In crude sewage, 12 days (Firth); in a septic tank, 14 days (Pickard); in butter, 4 months (Bailey and Field); in home-made cheese, 5 days (Welch); in pot-cheese, 12 days (Lemke); in ice cream, 39 days (Mitchell), etc.

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within twenty-four hours after excretion. When a case of typhoid fever occurs under rural conditions, chance is greatly in favor of the infecting organisms having left their former human host on the same day on which infection occurred. This date may be approximately set by counting back fourteen days (one to six weeks are the outside limits) from the date of onset of the infected individual. If an investigation is conducted within a reasonable time after the onset (two to three weeks) the events which transpired about the time of infection are well within the scope of recent memory and a fairly accurate account may be obtained.

The farm is more or less a community in itself. People living upon it frequently go days, even weeks, without intimate contact with individuals on an adjoining farm or in a nearby village. Intimate details concerning such contacts may be remembered for long periods.

Moreover, the history of each family in the neighborhood as regards typhoid is usually readily available.

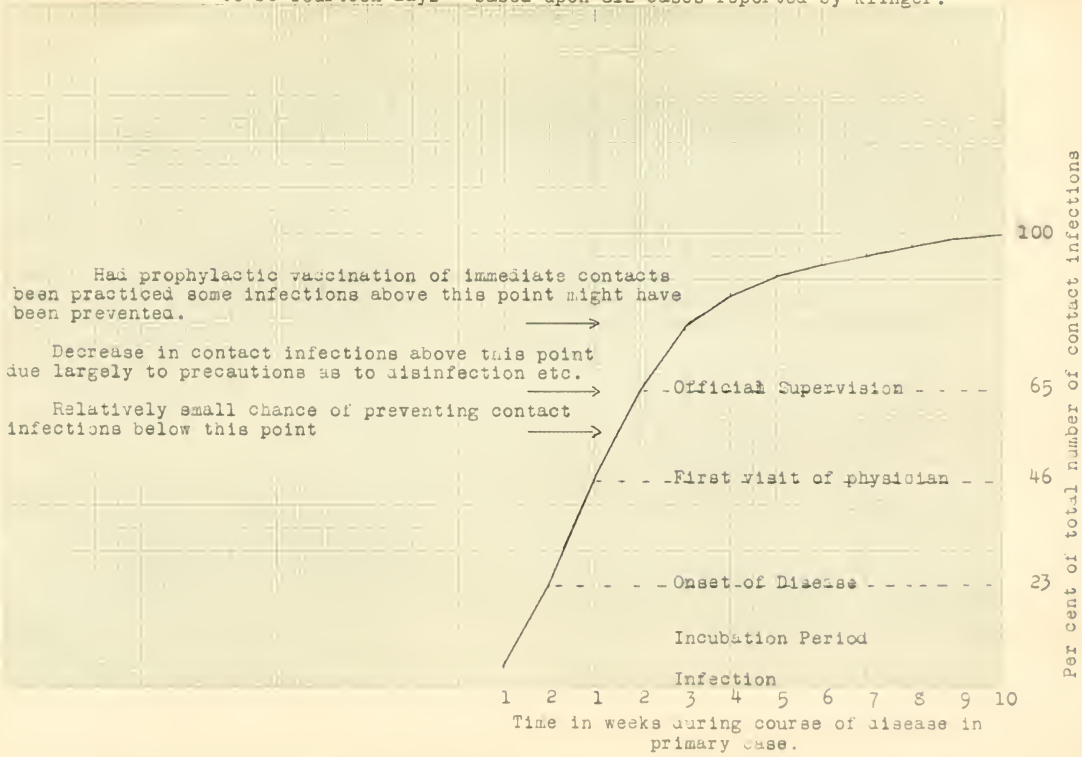
The vehicle of transmission need only receive incidental attention. In those (rare) cases in which polluted well-water is responsible, the human source of this pollution must have used the well or deposited excrement on the ground near the well within a comparatively short time. Prime interest may be centered in the persons who might have done this; their number is small and may be ascertained with great accuracy. If milk or other food is the vehicle, then the person who contaminated it must have assisted in its preparation on that farm on the day on which infection occurred. Again the possibilities are limited. If the fly has acted as intermediary, as may be the case in certain (rare) instances, he has brought his gift probably from a nearby neighbor, and previous history of typhoid in the neighborhood may point out the direction quite clearly. Experience in rural districts, however, emphasizes again and again, the importance of the "human-hand→food" route in the transmission of the disease as contrasted with water and milk as the vehicles in urban districts.

The correlation of the data obtained concerning personal contacts at or about the time the infection occurred (using fourteen days before the onset as the modal point) particularly with reference to the preparation of food, with the data obtained regarding previous history of typhoid in these individuals and in the neighborhood, usually gives a definite lead as to the most probable source or narrows the search down to a few "suspects". It then remains to secure specimens of urine and stool (repeatedly if necessary) to establish the exact identity of the carrier.

That detection of the source is practicable is indicated by numerous published reports. The a five outbreaks above reported constitute the successful searches in a series of seven attempts. In the campaign against typhoid in south-west Germany in 1906-07, which dealt largely with rural areas, both the means of transmission and the source of the infection was reasonably established in 36% (1457) of the cases that occurred in these two years. This should represent the minimum of accomplishment in an intensive campaign against the disease in this country to-day.

Concerning the actual possibilities of preventing secondary contact cases, Graph #4 based upon the figures given by Klinger[1], is of interest. Assuming the incubation period of the disease to be fourteen days he shows for 81% contact infections the time during the illness of the primary case when the secondary case received his infecting dose. The data is represents what actually happened in a rural area where an active campaign was being carried on against the disease. In some instances the primary case was removed to the hospital, in some instances isolated in the home, and in some instances refused medical aid. The average time before a physician was called was 6 days after the onset; before the case came under supervision 13 days; before concurrent disinfection was begun or the case removed to a hospital, 10 days. In other words, the average time elapsing between the onset and the institution of all measures of prevention (except vaccination of immediate contacts)was about 15 days. Apparently 70% of the contact cases that resulted were infected before the end of the third week of the disease in the primary case. Klinger admits that it would be a mistake to place too much reliance on the accuracy of the figures in view of the well known variation in the length of the incubation period

of the disease in the primary case - assuming the incubation period to be fourteen days - based upon 812 cases reported by Klinger.



and that the chance of the same donor having been responsible for both primary and secondary infections has not been completely excluded. Nevertheless, the graph brings out in a striking way the limitations in the way of preventing contact cases. Even had vaccination of immediate contacts been introduced the result could not have been very different. Under optimum conditions, vaccination ten days after the onset of the primary case and resultant immunity about ten days later, would have prevented the remaining one-third . Analysis of the situation only serves to bring out more clearly that effective prevention must anticipate the primary case,- must be carried to the strategic source - the chronic carrier.

The actual organization to carry out an intensive control of typhoid must of course be adapted to the particular field of operation and its already existing agencies. The essentials are a central (state) authority to act in an advisory capacity, coordinate the effort, cover the weak spots and furnish expert assistance, and a local (district or county) authority with sufficient personnel and funds to provide health insurance for the area rather than simply answer health alarms.

The first step in the field should be the "spotting" of endemic foci - individual farms and villages - in the district or county, and areas of high prevalence in the state. This will greatly facilitate local investigations and will indicate where effort should be concentrated.

The measures of control, in the order of their importance, can be grouped under three heads:

1. Prevention of cases secondary to
   a. Unrecognized cases
   b. Unrecognized carriers.

2. Prevention of cases secondary to
   a. Recognized cases.
   b. Recognized carriers.

4. Teaching and promotion of
   a. Personal hygiene
   b. Farm hygiene
   c. Community hygiene.

Direct responsibility for the program belongs to the local health authority. It should be provided, however, that whenever the local authority is unable to establish the human source of infection, he shall be compelled to immediately advise the central (state) authority. The latter, on its part, should be prepared to furnish a trained epidemiologist and the necessary laboratory facilities for a careful investigation.

The control of carriers should begin with the laboratory examination of specimens of urine and stool from convalescents to determine their freedom from typhoid bacilli. The enlightened portion of the public is beginning to demand this information as necessary for the safety of the family of the patient and friends. The state should strive to educate the public up to this precaution and see that the necessary laboratory facilities are provided. With the gradual extension of this policy no extra burden need be put upon an efficient public health laboratory service with its necessary sub-laboratories and co-operating laboratories.

The carriers found in routine laboratory examinations would be classified as temporary or permanent. The latter should be enrolled in a permanent register and followed up from time to time. To this register will be added the names of those carriers detected in epidemiological investigations. Local health officers should be kept fully posted concerning carriers in their jurisdiction. They should visit them at least two or three times per year (particularly during the "typhoid season") and, encourage them to take the necessary precautions and see that they keep out of food industries - particularly the production of dairy products for sale.

In rural areas, legal restraint of a carrier is seldom necessary. His condition should be confidential during good behaviour. If he becomes fractious and uncooperative, it is only necessary to let the information be known in the community. A "disease carrier" may be more thoroughly isolated socially than would be possible in a prison ward.

The views here presented are mine own. Justification for presenting them is found in the following clipping from a newspaper which fairly represents what is occurring in the rural areas of many states:

> " Will Brown, on the Reynolds place southwest of town, was slowly propelling himself around the stores last Saturday afternoon, his first time in town since he took down with typhoid fever three weeks or more ago. He was still weak but gaining strength rapidly, and his friends were indeed glad to see him out again. His illness was caused by a defective drain pipe in the well at their home, he said - this fact having been discovered by Dr. Kemper, county health officer, who inspected the well and condemned it. Mr. Brown considers it fortunate that no other member of his family contracted the fever."

It illustrates graphically three points: the wide spread of laymen in the origin of typhoid fever from sewage polluted water de novo which still exists; the health officer with the same confusion in his mind about "water-born" typhoid making the usual type of investigation and incriminating the well-water; and lastly, the convalescent patient, probably still excreting typhoid bacilli circulating among his friends.

If this episode is a fair sample of the administrative control of typhoid fever in rural areas, then one is forced to the conclusion that the general causes (to which reference has been made previously) and not the local causes (except possibly the more or less complete bedside disinfection which is generally carried out under the instruction of the attending physician) are responsible for the general decline of rural typhoid.